

# On the Sustainability of Budget Deficits of Central and Local Governments for Japan

著者	Hirai Takeyuki, Nomura Masuo
journal or publication title	THE NAGOYA GAKUIN DAIGAKU RONSHU; Journal of Nagoya Gakuin University; SOCIAL SCIENCES
volume	47
number	4
page range	65-71
year	2011-03-31
URL	<a href="http://doi.org/10.15012/00000214">http://doi.org/10.15012/00000214</a>

# On the Sustainability of Budget Deficits of Central and Local Governments for Japan

TAKEYUKI HIRAI<sup>\*</sup> and MASUO NOMURA<sup>\*\*</sup>

## Abstract

Following Payne and Mohammadi [2006], this note examines the sustainability of budget deficits of central and local governments for Japan over the period 1959–2003. We use the methodology of unit root test proposed by Perron [1997] which allows for an endogenous structural change in the sample data. For this purpose, we calculate critical values specific to our sample size because our sample size is very small. Payne and Mohammadi [2006] analyzed relatively large sample and obtained the sustainability of budget deficit for the U.S. However, from the results of tests for Japan, the sustainability of budget deficit is not supported even if a structural break in the budgetary process is considered. Our results are opposite of Payne and Mohammadi's results for the U.S. In Japan, the fiscal situation of both central and local government has deteriorated rapidly in the 1990's, and the fiscal sustainability is suspected in recent years. The results of this study suggest an important evidence for the issue of sustainability.

(JEL H62)

## Introduction

The sustainability of government budget deficit has been receiving considerable attention in most developed countries. In the literature on budget deficit sustainability, following Payne and Mohammadi [2006], there have been basically two approaches. The first approach is to examine the possibility of stationarity of budget deficit by conducting tests of unit root, that is, the 'strong form' of the budget deficit sustainability. The second approach is to examine the long-run relationship between government revenues and expenditures by conducting cointegration tests, that is, the 'weak form' of the budget deficit sustainability. See references of Payne and Mohammadi. Payne and Mohammadi suggested an interesting result that the U.S. budget deficit is sustainable in 'strong form' sense by the unit root test which allows for a structural break in the budgetary process though it is not by the

---

<sup>\*</sup> Faculty of Economics, Kagawa University, Japan; E-mail: hirai@ec.kagawa-u.ac.jp

<sup>\*\*</sup> Faculty of Economics, Nagoya Gakuin University, Japan; E-mail: nomura@ngu.ac.jp

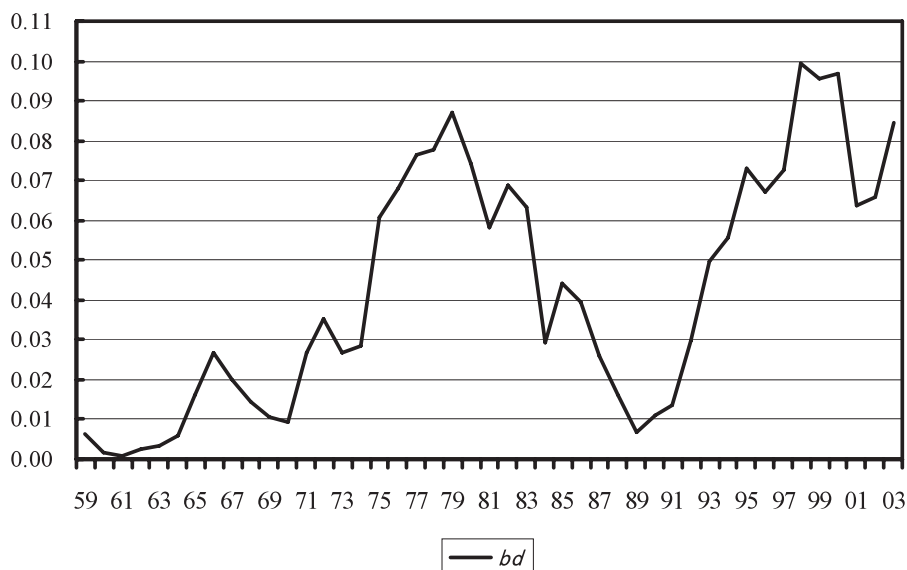
standard unit root test.

In Japan, the budget deficit was rapidly increased in the 1990's, and government has been suffering from huge budget deficit in recent years. The sustainability of the Japanese budget deficit became a serious problem. The empirical studies by Payne [1997] could not find support for the 'weak form' of sustainability for Japan. Also, his study has not considered the structural change in the sample data. In our study, we consider the budget deficit for the central and local governments together because the issue of local bonds is under the control of central government in Japan. Unlike Payne and Mohammadi [2006], we use annual data because there is not quarterly data for local government budget deficit. Allowing for an endogenous break in budgetary process, we will use the unit root test by Perron [1997] following Payne and Mohammadi. Our sample size is 45 observations, but existing critical values of test statistic, tabulated by Perron, are based on sample size of 60 or 70 observations. Sample size of Payne and Mohammadi was relatively large and they could use critical values of Perron for infinite sample. However, the analysis of using Perron's finite critical values is difficult for small sample data of Japan. As conjectured from discussion of Narayan [2005], the analysis by using the critical values of Perron for Japanese data may be biased.

Following Payne and Mohammadi [2006], the purpose of this note is to examine the 'strong form' of the budget deficit sustainability over the period 1959–2003 for Japan. Our approach is to analyze the time series property of budget deficit by unit root tests. For this purpose, we calculate critical values specific to our sample size because our sample size is very small. The rest of this note is organized as follows. In the following section, we explain the data and econometric methodology used to test the sustainability of budget deficit. The final section presents the results of the empirical analysis and concludes.

## Data and Methodology

In this study, we use annual observations for Japan over the period 1959–2003. The data for budget deficit is the integrated one of central and local governments. Though quarterly data for central government budget deficit are obtained, there are not quarterly data for local government budget deficit in Japan. Therefore, we use annual data, but our sample size is relatively small. Following Doi and Nakazato [1998], the scope of central government deficit is based on the General Account and the Special Account for Allocation and Transfer Taxes, and that of local government deficit is on the Ordinary Accounts of Local Governments. The data for central government deficit is acquired from the Annual Statistical Report on Central Government Debt (Ministry of Finance, MOF), and the data for local government deficit is from the Annual Statistical Report on Local Government Finance (Ministry of Internal Affairs and Communications, MIC). The data used in this study is different from that used by Payne [1997] for Japan in two respects. First, while Payne [1997] uses annual data from IMF, we do



**Figure1** Japanese Budget Deficit/GDP: 1959–2003

**TABLE 1** Summary Statistics of Japanese Budget Deficit/GDP: 1959–2003

Summary Statistics	
Mean	0.042434
Median	0.035227
Maximum	0.099344
Minimum	0.000884
Standard derivation	0.030452
Skewness	0.247348
Kurtosis	1.720357
Jarque-Bera	3.529143
	(0.171260)

Note: Probability value is in parenthesis.

the integrated data of Japanese central and local governments based on the information from MOF and MIC in Japan. Second, the most recent annual data set which extends the sample from 1959 to 2003 is used in the analysis.

The budget deficit ( $bd_t$ ) in the analysis is measured as the ratio of budget deficit to GDP. Figure 1 displays the behavior of the Japanese budget deficit/GDP ratio. In particular, the budget deficit in the 1990's underwent a rapid increase with the collapse of 'bubble economy' in 1991 and the long period of recession in afteryears. Table 1 reports the summary statistics of budget deficit,  $bd_t$ . The Jarque-Bera test reveals that the budget deficit follows a normal distribution. The results of ADF unit root test for the budget deficit,  $bd_t$ , are reported in Panel A of Table 2. The standard unit root tests suggest that the budget deficit is non-stationary. Thus, its sustainability is questionable. However, as evident in Figure

TABLE 2 Unit Root Tests for Japanese Budget Deficit/GDP: 1959–2003

A: Unit Root Tests	ADF Statistics	Lag( $k$ )
ADF(C) $bd_t$	– 1.3612846	0
ADF(C) $\Delta bd_t$	– 5.8248443 <sup>a</sup>	0
ADF(C+T) $bd_t$	– 3.2533496 <sup>c</sup>	5
ADF(C+T) $\Delta bd_t$	– 5.7495406 <sup>a</sup>	0

Notes: ADF(C) and ADF(C+T) denote ADF tests based on the regression equations with a constant, and with a constant and a time trend, respectively. For ADF statistic, lag length,  $k$ , is selected by using  $t$ -sig criterion starting with  $k_{\max}=5$ . The critical values for 50 observations and ADF(C), tabulated by Fuller (1996), are 1% = –3.59, 5% = –2.93, and 10% = –2.60%. The critical values for 50 observations and ADF(C+T), tabulated by Fuller (1996), are 1% = –4.16, 5% = –3.50, and 10% = –3.18%. Note that a, b and c denote 1%, 5%, and 10% significance levels, respectively.

#### B: Perron's Endogenous Unit Root Tests

##### Model 1:

$$bd_t = -0.010661 - 0.036757DU + 0.002328t + 0.017646D(T_b) + 0.236735bd_{t-1} + e_t$$

(–1.284479) (–2.602666)<sup>a</sup> (3.056031)<sup>a</sup> (1.038393) (1.287452)

Number of augmented lags  $k=5$

Break Date 1985( $T_b=27$ )

$t(\alpha=1)$  –4.1509127

Notes: Lag length,  $k$ , is selected by using  $t$ -sig criterion starting with  $k_{\max}=5$ . The coefficients of  $k$  lagged difference terms in the regression are not reported.  $t$ -statistics are in parentheses. Note that  $t(\alpha=1)$  is the  $t$ -statistic for testing  $\alpha=1$  under Model 1 with a break date,  $T_b$ , and lag length,  $k$ . For  $T=45$ , finite-sample critical values of  $t$ -statistic on  $\alpha$  in equation (1) are 1% = –6.200, 5% = –5.409, and 10% = –5.057. Note that a, b, and c denote 1%, 5%, and 10% significance levels, respectively.

##### Model 2:

$$bd_t = 0.056582 - 0.037824DU - 0.005697t + 0.005939DT - 0.022446D(T_b) + 0.47591bd_{t-1} + e_t$$

(1.558404) (–1.031817) (–1.429017) (1.489647) (–1.594478) (3.732642)<sup>a</sup>

Number of augmented lags  $k=5$

Break Date 1969( $T_b=11$ )

$t(\alpha=1)$  –4.114

Notes: See notes in Model 1 for the selection of lag length,  $k$ , and the result of regression analysis. Note that  $t(\alpha=1)$  is the  $t$ -statistics for testing  $\alpha=1$  under Model 2 with a break date,  $T_b$ , and lag length,  $k$ . For  $T=45$ , finite-sample critical values of  $t$ -statistic on  $\alpha$  in equation (2) are 1% = –6.466, 5% = –5.811, and 10% = –5.449. Note that a, b, and c denote 1%, 5%, and 10% significance levels, respectively.

1, it may be possible that the budget deficit for Japan also experienced a structural shift as seen in Payne and Mohammadi [2006] for the U.S. budget deficit.

In order to discern this possibility, the methodology of unit root test proposed by Perron [1997] which allows for an endogenous structural change is used following Payne and Mohammadi [2006]. As illustrated below, we use two Innovational Outlier (IO) models of Perron [1997]. See equations (1) and (2) in Perron [1997, p. 358]. As the first model (Model 1), the unit root test is performed using the  $t$ -statistic for testing  $\alpha=1$  in the following regression:

$$\text{Model 1: } bd_t = \mu + \theta DU_t + \beta t + \delta D(T_b)_t + \alpha bd_{t-1} + \sum_{i=1}^k c_i \Delta bd_{t-i} + e_t. \quad (1)$$

where  $DU_t = 1(t > T_b)$  and  $D(T_b)_t = 1(t = T_b + 1)$  with the indicator function  $1(\cdot)$  are the dummy variable;  $T_b$  denotes the time at which the change in the trend function occurs;  $t$  is a linear time trend;  $\Delta$  is the first-difference operator;  $e_t$  are white noise error terms. We conduct regression (1) for  $k+2 \leq T_b \leq T-2$ , where  $T$  is the sample size. Moreover, as the second model (Model 2), the test is performed using the  $t$ -statistic for the null hypothesis that  $\alpha = 1$  in the regression:

$$\text{Model 2: } bd_t = \mu + \theta DU_t + \beta t + \gamma DT_t + \delta D(T_b)_t + \alpha bd_{t-1} + \sum_{i=1}^k c_i \Delta bd_{t-i} + e_t. \quad (2)$$

where  $DT_t = 1(t > T_b)t$  is the dummy variable. We conduct regression (2) for  $k+3 \leq T_b \leq T-3$ . In equations (1) and (2), the break date,  $T_b$ , and lag length,  $k$ , are treated as unknown. The break date,  $T_b$ , is selected based on the minimum  $t$ -statistic for testing  $\alpha = 1$  (see Perron, 1997, pp. 358–359). For each  $T_b$ , the selection of lag length,  $k$ , is selected by  $t$ -sig criterion with maximum lag length,  $k_{\max} = 5$  (see Perron, 1997, p. 359).

As mentioned above, because we use annual data, the sample size in this study is  $T = 45$  observations. The critical values of  $t$ -statistic on  $\alpha$  are available in Perron [1997] for  $T = 60, 80, 100, \infty$  in equation (1) and  $T = 70, 100, \infty$  in equation (2). However, because our sample size is relatively small, we calculate critical values specific to our sample size by using the Monte Carlo simulations. Following Perron, the data are generated by random walk,  $y_t = y_{t-1} + e_t$  ( $t = 1, 2, \dots, T$ ) with  $y_0 = 0$  and  $e_t \sim \text{i.i.d. } N(0, 1)$ . By using equations (1) and (2), we present the critical values for  $T = 45$  observations. The results were obtained using 10000 replications by GAUSS program.

## Results and Concluding Remarks

This note examines the sustainability of budget deficit over the period 1959–2003 for Japan. For this purpose, following Payne and Mohammadi [2006], we analyze the time series property of budget deficit by unit root tests. In particular, considering the possibility of a structural break in budgetary process, we use the method of unit root test proposed by Perron [1997] which allows for an endogenous structural change. Furthermore, we consider the budget deficit for the central and local governments together because the issue of local bonds is under the control of central government in the Japanese fiscal system.

Panel B of Table 2 reports the results of Perron's [1997] endogenous unit root tests. In the table, the results of regression analysis are presented based on the selected break date,  $T_b$ . Note that  $t(\alpha = 1)$  is the  $t$ -statistic for testing  $\alpha = 1$  with a break date,  $T_b$ , and lag length,  $k$ . The critical values for  $T = 45$  are presented in notes of the table. First, for Model 1, the break date of 1985 and lag length,  $k = 5$ , are selected. From the value of  $t(\alpha = 1)$ , the null hypothesis that  $\alpha = 1$  is not rejected at the

10% significance level. Second, for Model 2, the break date of 1969 and lag length,  $k=5$ , are selected. The value of  $t(\alpha=1)$  also shows that the null hypothesis is not rejected at the 10% significance level. Thus, even if we allow for an endogenous break in the budgetary process, the ‘strong form’ of budget deficit sustainability is not supported for Japan.

For both of models 1 and 2, selected lag length,  $k=5$ , coincides with  $k_{\max}=5$ . We also conducted unit root tests for model 1 and 2 by using  $k_{\max}=6$ . For model 1, the break date of 1985 and lag length,  $k=5$ , are selected, and the value of test statistic is  $-4.151$ . For model 2, the date of 1969 and  $k=5$  are selected, and the value of test statistic is  $-4.114$ . Also, two values of test statistic are not significant at the 10% significance level. Thus, the results for panel B of Table 2 are not biased by coinciding  $k_{\max}$  and selected lag length.

In comparison with the analysis of Payne and Mohammadi [2006] for the U.S., first, our sample size is relatively small though that of Payne and Mohammadi is relatively large. Payne and Mohammadi [2006] could use critical values of Perron [1997] for infinite sample. However, in the case of Japanese small sample data, the analysis by using the critical values of Perron may be biased. Therefore, we calculate critical values specific to our sample size. Second, there is a difference between the U. S. and Japan for results of sustainability. As shown in Payne and Mohammadi [2006], the U. S. budget deficit is sustainable in ‘strong form’ sense by the unit root test which allows for a structural break in the budgetary process though it is not by the standard unit root test. However, the results of tests in this study present that the ‘strong form’ of budget deficit sustainability is not supported even if we allow for an endogenous break in the budgetary process. Our results are opposite of Payne and Mohammadi’s results for the US. In addition, Payne and Mohammadi [2006] considered only the model 2. It is stressed that our results was obtained by both of models 1 and 2. The model 1 allows only a change at break date,  $T_b$ , in the intercept under both the null and alternative hypotheses. Under the model 2, both a change in the intercept and the slope are allowed at break date.

The results of tests using two IO models of Perron [1997] also reinforce the results of sustainability by Payne [1997], which presented that the ‘weak form’ of budget deficit sustainability is not supported for Japan. However, this study uses data sources which are different from those in Payne [1997] because we explicitly consider not only the deficit of central government but also that of local government. Moreover, we use the most recent annual data set which extends the sample from 1959 to 2003. Our results present that the ‘strong form’ of budget deficit sustainability is not also supported for Japan. Furthermore, even if a structural change is considered in budgetary process, we can not find the support for fiscal sustainability in the country like Japan which suffers from huge budget deficit. In Japan, the fiscal situation of both central and local government has deteriorated rapidly in the 1990’s, and the fiscal sustainability is suspected in recent years. The results of this study suggest an important evidence for the issue of sustainability. Therefore, Japanese government needs to implement the drastic fiscal reform.

Finally, though, in this study, we compare the sustainability of budget deficit for Japan with results of U. S. budget deficit study by Perron and Mohammadi (2006), future research is to examine Japanese fiscal sustainability in comparison with the other developed countries.

\*We are grateful to Dr Gabriella Legrenzi for helpful comments.

## References

- Doi, T.; Nakazato, T. "The Sustainability of National and Local Government Deficits in Japan," *Financial Review*, 47, 1998, pp. 76–105 (in Japanese).
- Fuller, W. A. *Introduction to Statistical Time Series* (second edition), New York: John Wiley & Sons, 1997.
- Narayan, P. K. "The Government Revenue and Government Expenditure Nexus: Empirical Evidence from Nine Asian Countries," *Journal of Asian Economics*, 15, 6, 2005, pp. 1203–1216.
- Payne, J. E. "International Evidence on the Sustainability of Budget Deficits", *Applied Economics Letters*, 4, 12, 1997, pp. 775–779.
- Payne, J. E.; Mohammadi, H. "Are Adjustments in the U.S. Budget Deficit Asymmetric? Another Look at Sustainability," *Atlantic Economic Journal*, 34, 1, 2006, pp. 15–22.
- Perron, P. "Further Evidence on Breaking Trend Functions in Macroeconomic Variables, *Journal of Econometrics*, 80, 2, 1997, pp. 355–385.